

CLAIMS

What is claimed is:

1. An acceleration sensor comprising:
an acceleration sensor chip having
a mass portion located in the center of the acceleration sensor chip,
a thick frame surrounding the mass portion and being at a distance from the mass portion and having a plurality of recesses on an upper surface of the thick frame,
a plurality of elastic support arms bridging an upper surface of the mass portion and the upper surface of the thick frame, and
strain gauges formed on upper surfaces of the elastic support arms; and
an upper regulation plate mounted with a predetermined gap between the upper surface of the mass portion and a lower surface of the upper regulation plate to cover the acceleration sensor chip and fixed on the upper surface of the thick frame by a paste put in the plurality of the recesses on the upper surface of the thick frame,
wherein the paste is adhesive mixed with hard plastic balls of diameters larger than the predetermined gap between the upper surface of the mass portion and the lower surface of the upper regulation plate.
2. An acceleration sensor as set forth in claim 1, wherein the hard plastic balls are of diameters equal to or smaller than the sum of the predetermined gap and a depth of the recesses.
3. An acceleration sensor as set forth in claim 1, wherein the paste contains 1 to 40 mass % of the hard plastic balls having diameters of 12 μm or larger, and the balance being silicon-rubber resin adhesive of Young's Modulus less than 10^2 G Pa after hardened.
4. An acceleration sensor as set forth in claim 1, wherein the total area of the plurality of the recesses located on the upper surface of the thick frame is 5 to 35 % of the area of the upper surface of the thick frame.

5. An acceleration sensor as set forth in claim 3, wherein the total area of the plurality of the recesses located on the upper surface of the thick frame is 5 to 35 % of the area of the upper surface of the thick frame.

6. An acceleration sensor as set forth in claim 4, wherein each of the recesses located on the upper surface of the thick frame has a side opening on an outer side surface of the thick frame.

7. An acceleration sensor as set forth in claim 5, wherein each of the recesses located on the upper surface of the thick frame has a side opening on an outer side surface of the thick frame.

8. An acceleration sensor as set forth in claim 6, wherein the thick frame is rectangular, and each of the recesses is located in each of the corners of the rectangular thick frame.

9. An acceleration sensor as set forth in claim 7, wherein the thick frame is rectangular, and each of the recesses is located in each of the corners of the rectangular thick frame.

10. An acceleration sensor device comprising:
an acceleration sensor comprising:

an acceleration sensor chip having

a mass portion located in the center of the acceleration sensor chip,

a thick frame surrounding the mass portion and being at a distance from the mass portion and having a plurality of recesses on an upper surface of the thick frame,

a plurality of elastic support arms bridging an upper surface of the mass portion and the upper surface of the thick frame, and

strain gauges formed on upper surfaces of the elastic support arms; and

an upper regulation plate mounted with a predetermined gap between the upper

surface of the mass portion and a lower surface of the upper regulation plate to cover the acceleration sensor chip and fixed on the upper surface of the thick frame by a paste put in the plurality of the recesses on the upper surface of the thick frame,
the paste being adhesive mixed with hard plastic balls of diameters larger than the predetermined gap between the upper surface of the mass portion and the lower surface of the upper regulation plate, and
a protection case having a side frame and an inner bottom plate surrounded by the side frame,
wherein a lower surface of the thick frame is fixed on the inner bottom plate by adhesive with a second predetermined gap between a lower surface of the mass portion and the inner bottom plate to install the acceleration sensor in the protection case.

11. An acceleration sensor device as set forth in claim 10, wherein the lower surface of the thick frame is fixed on the inner bottom plate with the second predetermined gap between the lower surface of the mass portion and the inner bottom plate by a paste that is adhesive mixed with hard plastic balls.

12. An acceleration sensor device as set forth in claim 11, wherein the paste contains 1 to 40 mass % of the hard plastic balls having diameters of 12 μm or larger, and the balance being silicon-rubber resin adhesive of Young's Modulus less than 10^{-2} G Pa after hardened.

13. An acceleration sensor device as set forth in claim 12, wherein the total area of the plurality of the recesses located on the upper surface of the thick frame is 5 to 35 % of the area of the upper surface of the thick frame.

14. An acceleration sensor device as set forth in claim 13, wherein each of the recesses located on the upper surface of the thick frame has a side opening on an outer side surface of the thick frame.

15. An acceleration sensor device as set forth in claim 14, wherein the thick frame is rectangular, and each of the recesses is located in each of the corners of the rectangular thick frame.

16. An acceleration sensor device as set forth in claim 10, wherein the acceleration sensor chip further has

a plurality of first input/output terminals on the upper surface of the thick frame,
and

conductors each connecting each of the first input/output terminals with the strain gauge along from the upper surface of the elastic support arm having the strain gauge to the upper surface of the thick frame;

the protection case has on the side frame a plurality of second input/output terminals each of which is connected with each of the first input/output terminals by a lead wire; and
the upper regulation plate has a side opening on a side, corresponding to the first input/output terminals, of the upper regulation plate to allow the lead wire to pass through the side opening and to prevent the lead wire from contacting the upper regulation plate.

17. An acceleration sensor device as set forth in claim 15, wherein the acceleration sensor chip further has

a plurality of first input/output terminals on the upper surface of the thick frame,
and

conductors each connecting each of the first input/output terminals with the strain gauge along from the upper surface of the elastic support arm having the strain gauge to the upper surface of the thick frame;

the protection case has on the side frame a plurality of second input/output terminals each of which is connected with each of the first input/output terminals by a lead wire; and
the upper regulation plate has a side opening on a side, corresponding to the first input/output terminals, of the upper regulation plate to allow the lead wire to pass through the side opening and to prevent the lead wire from contacting the upper regulation plate.